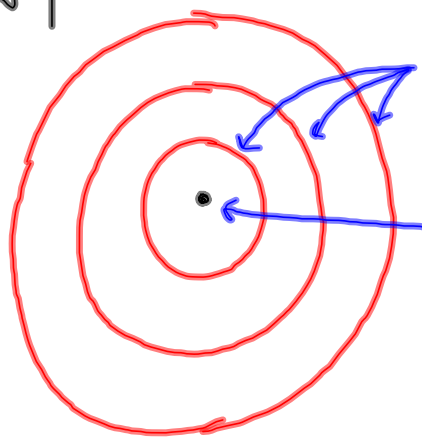
Quiz Wednesday on Sound

HW: p. 413: 2, 5, 6

p. 427: 1, 3

Doppler Effect:

- Stationary:

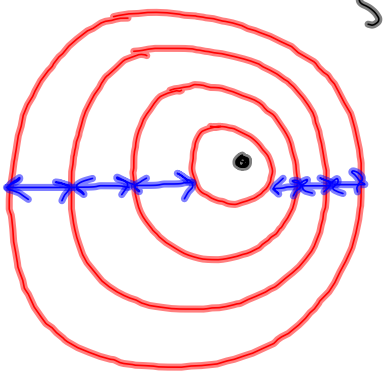


lines represent places of air compression

spaces represent places of air rarefaction.

- Relative motion:

either particle moving to the right or the surface moving to the left



λ is shorter → higher frequency

(blue shift)

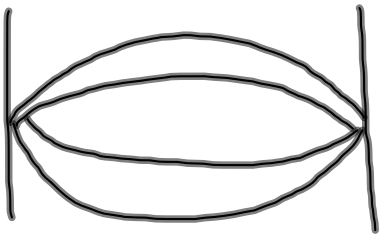
λ is longer → lower frequency

(red shift)

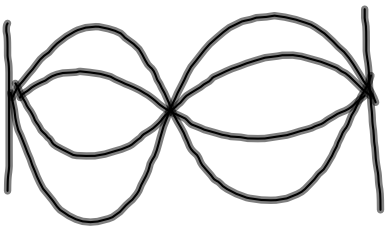
$$V = \lambda f$$

$$f = \frac{V}{\lambda}$$ → stays constant

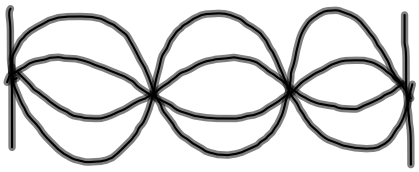
Standing Waves on a String:



fundamental frequency or first harmonic



second harmonic



third harmonic

$$f_n = \frac{nv}{2L} \qquad n = 1, 2, 3, \ldots$$

$f_n \rightarrow$ frequency of the harmonic

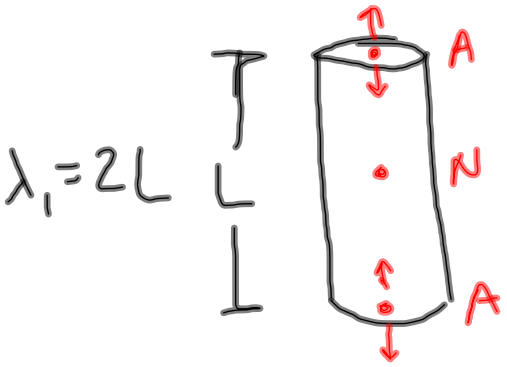
$n \rightarrow$ # of harmonic (all integers)

$v \rightarrow$ speed of the wave on the string

$L \rightarrow$ length of the string

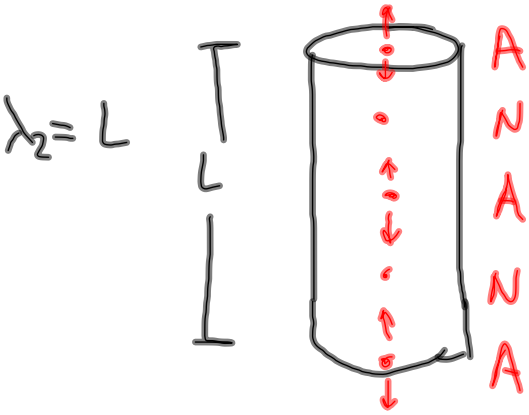
Standing Waves in an Air Column:

– Open / Open pipe
(both ends open)

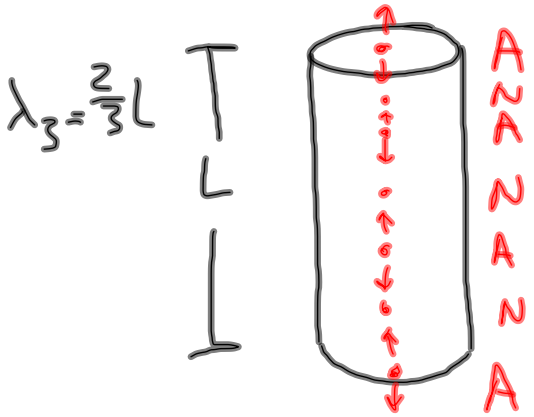


at open ends, always an antinode

first harmonic



second harmonic

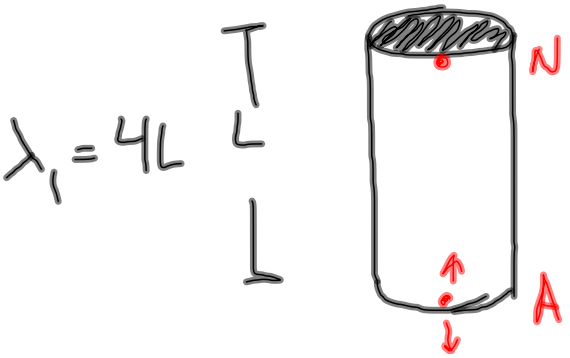


third harmonic

$$f_n = \frac{nv}{2L} \qquad n = 1, 2, 3, \ldots$$

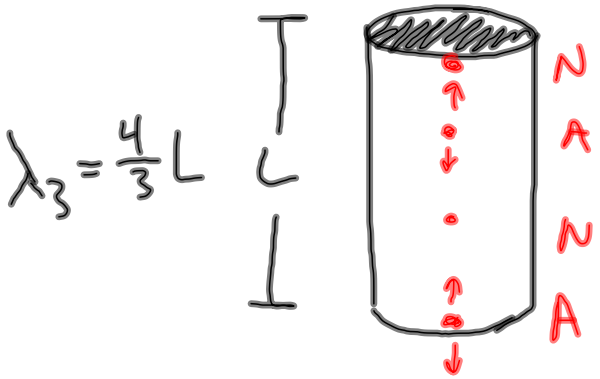
- Open/closed pipe

(open on one end, closed on the other)



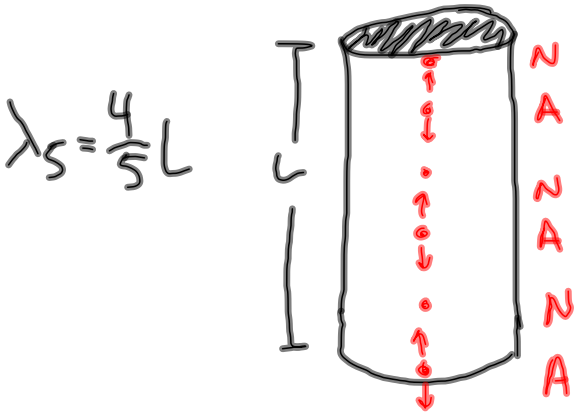
first harmonic

always a node at closed end



third harmonic

Even harmonics for an open/closed pipe DO NOT EXIST!



fifth harmonic

$$f_n = \frac{nv}{4L} \qquad n = 1, 3, 5, \ldots$$

What are the first three harmonics in a 2.45 m long pipe that is open at both ends? What are the first three harmonics of this pipe when one end of the pipe is closed? Assume that the speed of sound in air is 345 m/s.

open/open: $f_n = \frac{nv}{2L}$ $L = 2.45\ m$ $v = 345\ m/s$

$$f_1 = \frac{(1)(345\ m/s)}{2(2.45\ m)} = 70.4\ Hz$$

$$f_2 = \frac{(2)(345\ m/s)}{2(2.45\ m)} = 140.8\ Hz$$

$$f_3 = \frac{(3)(345\ m/s)}{2(2.45\ m)} = 211\ Hz$$

open/closed: $f_n = \frac{nv}{4L}$ $n = 1, 3, 5, \ldots$

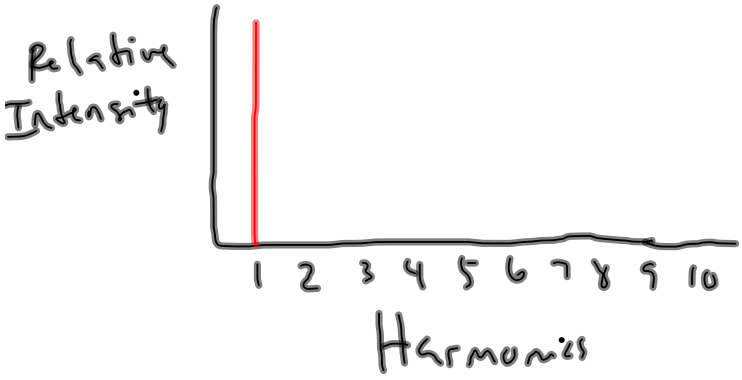
$$f_1 = \frac{(1)(345\ m/s)}{4(2.45\ m)} = 35.2\ Hz$$

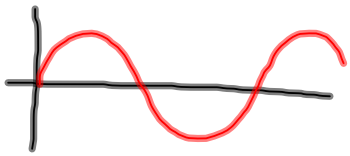
$$f_3 = \frac{(3)(345\ m/s)}{4(2.45\ m/s)} = 106\ Hz$$

$$f_5 = \frac{(5)(345\ m/s)}{4(2.45\ m)} = 176\ Hz$$

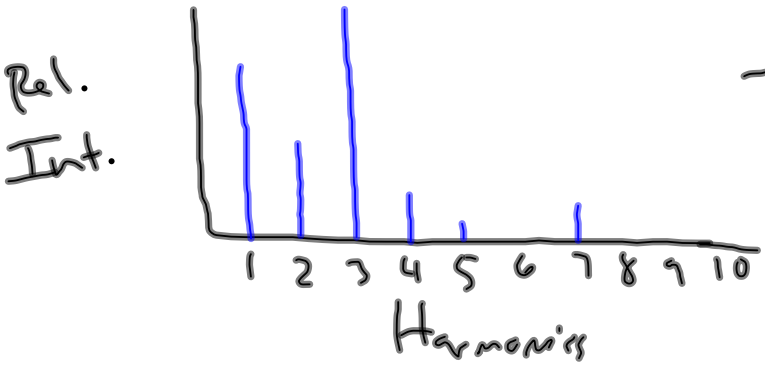
Sound Quality → Timbre

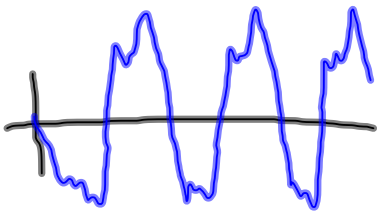
Tuning fork





Clarinet





Viola